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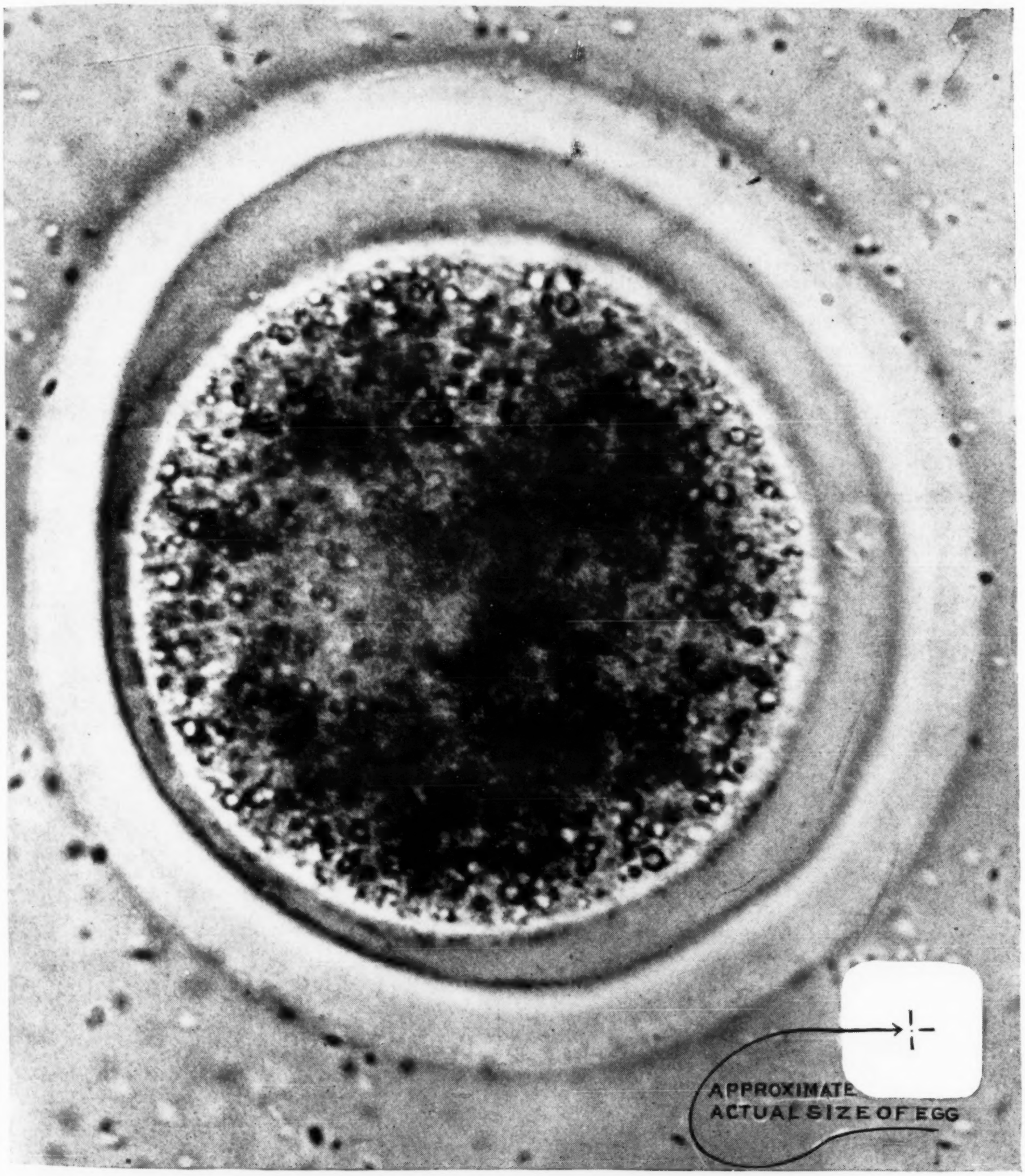

A COW'S EGG—SEVEN HUNDRED TIMES ENLARGED

(SEE PAGE 143)

Genius and Heredity

A "Penguin" Guinea

VOLUME 23 MAY, 1932 NUMBER 5

The American Genetic Association

An incorporated organization devoted to promoting a knowledge of the laws of heredity and their application to the improvement of plants, animals, and human racial stocks

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The

Journal of Heredity

Vol. XXIII MAY, 1932 No. 5

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COMING

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Another nerve defect that is inherited.

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Variations in degree of identity as exemplified by finger-print patterns. The most strikingly similar set had multiple birth membranes.

White Sheath in Maize

A character controlled by two complementary factors.

Wheat-Emmer Hybrids

Species hybrids of certain varieties show an unusual degree of fertility.

Wooly-Haired Nordics

A dominant mutation, producing in a blond race a frizzle-haired condition characteristic of the negro races.

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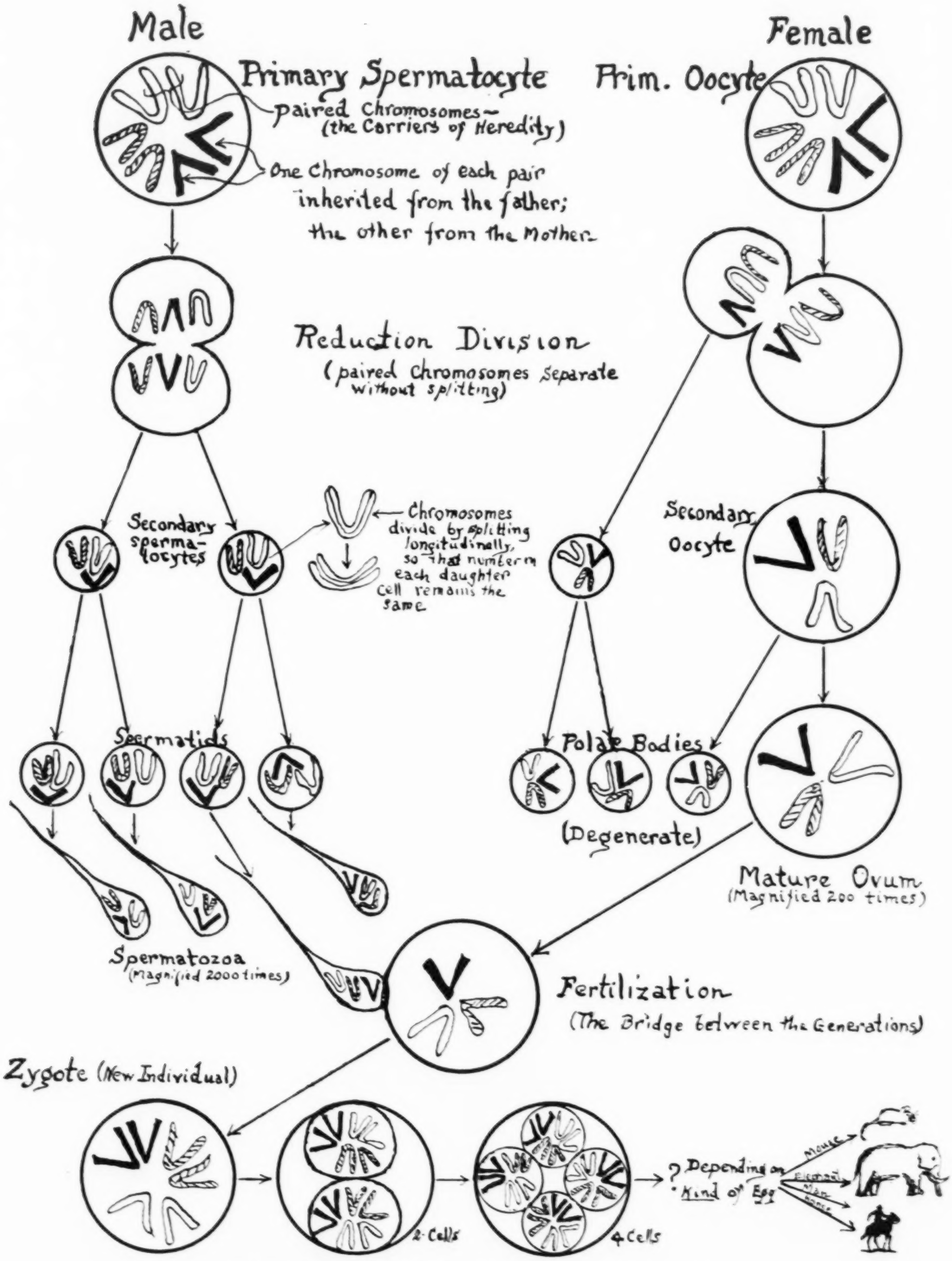


THE MECHANISM OF FERTILIZATION

Frontispiece

The one-celled stage through which all the higher forms of life pass is shown diagrammatically here. The spermatocytes and oocytes develop from the germ-tract, which is made up of undifferentiated tissue set aside early in the embryonic development of the higher animals. Individual cells in this germinal tissue develop to form the mature germ cells, and above are outlined the more important features of this process: the reduction division, in which the paired chromosomes separate; and fertilization, when the full complement of chromosomes is reassembled by union of ovum and sperm. Actual photographs of egg and sperm cells are shown in Figures 1 and 2. The sperm cells in this drawing are ten times as much magnified as the egg cell, to show the details of chromosome transmission. The adult organism may be made up of billions of cells, of such form and function as to constitute a mouse, an elephant or a Shakespeare, but in this single tiny fertilized egg cell is contained *all the potentialities of the final form*—and nothing can be *inherited* in the biological sense except what is transmitted by these microscopic objects. (In the higher animals many more pairs of chromosomes are present, but the principles are the same.)

A ONE-CELLED COW

Photographs of Bovine Eggs Illustrate the Microscopic "Living Bridge" Which Joins the Generations

IT is hard to realize that with all the complexities life has attained, and with all the specialization of structure and function that has been developed, the living link that joins one generation to the next is still today, as it was millions (even billions?) of years ago, a single microscopic cell. That this is a biological truism makes it no less marvelous when we consider that all the hereditary potentialities that are transmitted from generation to generation cross a Bridge of Life so tiny that in mammals one component of it is altogether too small to be seen by the human eye, while the other is just on the verge of visibility. Mice and elephants, giraffes, and tapirs and humans, all go through this invisible single-celled haploid "generation," in which the tails, trunks, necks, noses, and brains, and all the multitude of other distinguishing differences, are preserved with an incredible precision of microscopic detail.

Under the microscope it is safe to say that it would be extremely difficult to tell an elephant in the one-celled stage from a monkey or a tapir or a giraffe. Hidden in this tiny object are much finer details than those that separate genera. Given a dozen fertilized cow eggs, could any one tell by the most refined methods which will be a Holstein, which a Jersey, which a bull, which a heifer, which will yield 5,000 pounds of milk and which 20,000? Given an array of human eggs, the detection of giants and dwarfs, either mental or physical, would be altogether impossible. Extremely fine details of structure and function are just as accurately and irrevocably determined—pits in the ear, webs between a certain pair of toes and such disasters as Huntington's chorea that may not become manifest for two-score years or more. There is room for all this in a speck of protoplasm whose volume is measured in cubic microns!*

One wonders what would be the effect on the philosophy of the next generation if this story of the Perpetuation of Life could be properly, dramatically and adequately expounded. If our billion dollar school system could really, livingly and vitally convey this one fact, the effect might be almost incalculable.

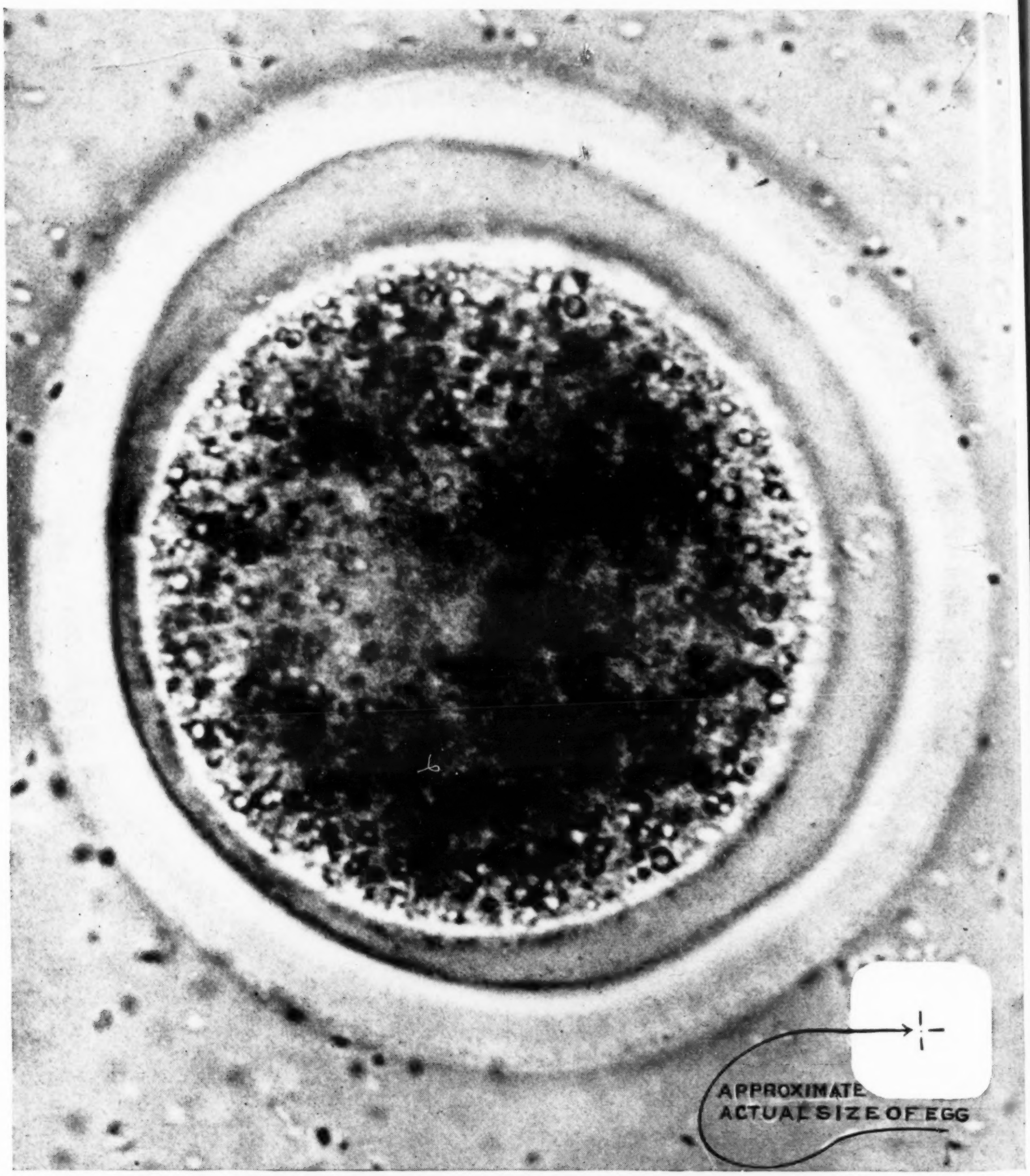
The occasion for this "sermon" is a recently published report† describing the "capture" of two cows, one in the single-celled haploid stage and the other in a more advanced stage of development boasting two complete cells and a complete "diploid" set of chromosomes. The details of this discovery are of considerable interest in the light they throw on the reproductive cycle in cattle. Important as this information may be, it is overshadowed in popular interest by the "portraits" of these one- and two-celled cows, which accompanied the article. Through the courtesy of the Bureau of Dairy Industry these are reproduced herewith.

Size of Egg and Sperm

The estimated diameter of the single-celled egg (Figure 1) is about 143 microns. When it comes to forming a mental concept of what they are, microns are about as unsatisfactory as light-years. In terms of familiar objects, just what does 143 microns mean? The paper on which this is printed averages about 275 sheets to the inch, or roughly 11 sheets to the millimeter. Thus 11 sheets are about 1,000 microns thick, and each sheet is about 90 microns thick. The diameter of the egg, in-

*A micron is one-twenty-five thousandth of an inch.

† MILLER, FRED W., W. W. SWETT, CARL G. HARTMAN and WARREN H. LEWIS. A Study of Ova from the Fallopian Tubes of Dairy Cows, with a Genital History of the Cows, *Journal of Agricultural Research* 43:(7) 627-636. 1931.



Photograph by C. C. Hartman and Warren H. Lewis

A ONE-CELLED COW—THE BOVINE EGG

Figure 1

The one-celled stage of the cow is almost invisible to the naked eye. The small dot, in the center of the white square, is approximately the size of the actual egg. This photograph, which is of the first unfertilized egg to be discovered, is greatly enlarged (750 diameters). Were it possible to imagine the cow that bore it enlarged to the same scale, she would be higher than the Empire State Building and her shadow at noon would cover a 240 acre farm. In the center of this remarkable photograph is the granulated protoplasm which conceals from view the carriers of heredity—the chromosomes. Two envelopes surround this precious bit of living matter and protect it. They appear as a lighter and a darker zone in the photograph. It is an amazing fact that this almost invisible particle is a cosmos of activities and that it carries in it—transmits as they say—half of those entities called chromosomes which, paired with similar entities from the sperm cell of the male, determine the characteristics of the calf.

Photograph from Bureau of Dairy Industry

THE TINY SPERM CELLS CONTRIBUTE HALF THE HEREDITY

Figure 2

The sperms, swiftly swimming cells (in proportion to their size), are vastly smaller than the egg. A hundred of them are shown in this photograph. They are produced with prodigal abundance, and in the process of fertilization swarms of them may swim about the egg cell, but only a single one succeeds in penetrating the envelopes and burying itself in the protoplasm of the egg. (Magnified about 1,500 times.)

The entities called chromosomes within the egg cell, upon the arrival on the scene of the chromosomes of the male (which are packed into the head of the sperm cell) begin immediately to range themselves in a definite pattern, suggesting the struts and beams of a complicated structure—which in fact this incredibly tiny object is—a real living bridge.

cluding its envelopes is approximately represented by the thickness of the edges of two sheets.*

An attempt is also made in the illustration (Figure 1) to convey an idea of this size. In the white space in the corner is a single dot at the intersection of the guide lines. This is a square, of which the edges have a length of between 150 and 200 microns. The dot would be expected to increase somewhat in size during the printing process. It is realized that this is only a rough approximation which will vary somewhat from one impression to the next, but it serves to give an idea of the minute dimensions of the most important and valuable form of matter—living or non-living—the reproductive cell.

Small as it is, a mammalian egg is fairly well filled with "waste material" from the point of view of hereditary transmission. The volume of the cow's egg shown in Figure 1 is just over a million and a half cubic microns. Contributing one-half the inherited characteristics and thus equally potent from the point of view of heredity, are the tiny sperm cells (Figure 2), which at fertilization furnish a complimentary set of chromosomes and initiate the development of a new individual. This picture is enlarged twice as much as the illustration of the egg in Figure 1.

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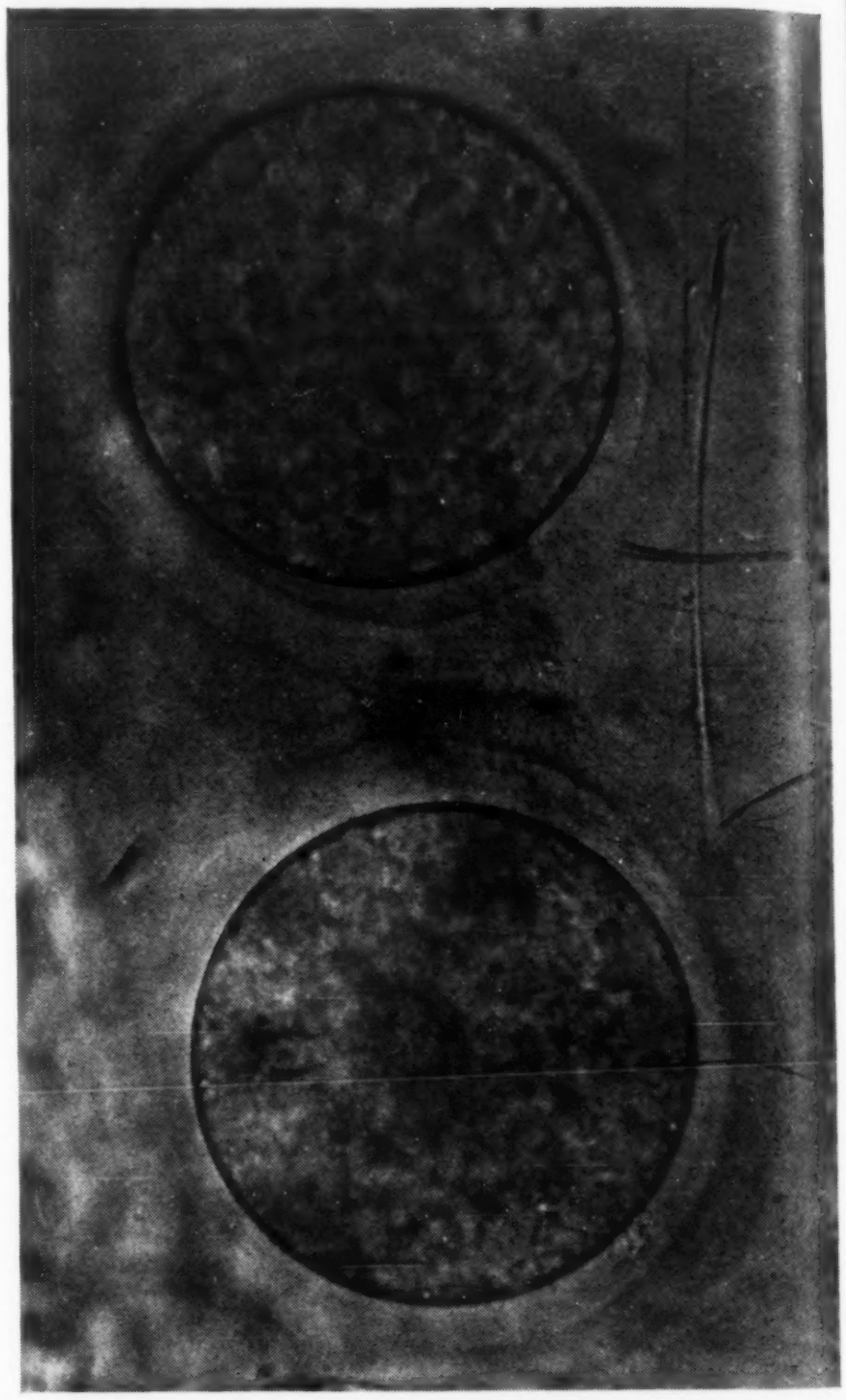
halves are equal, but biologically, one half may be 50,000 times as large as the other! About 8,000 of the sperm cells could be laid side by side in one inch. Each of them contains the potentialities for the production of a new individual. Is it inaccurate or irreverant to feel that we have in this process actual miracles that are still entirely beyond our understanding?

Surrounding the central portion of the egg is the zona, a covering, probably a secretion from the egg itself. The vital part of the egg is the dark central portion, which contains the chro-



Photograph by Joseph Long

RATS EGGS

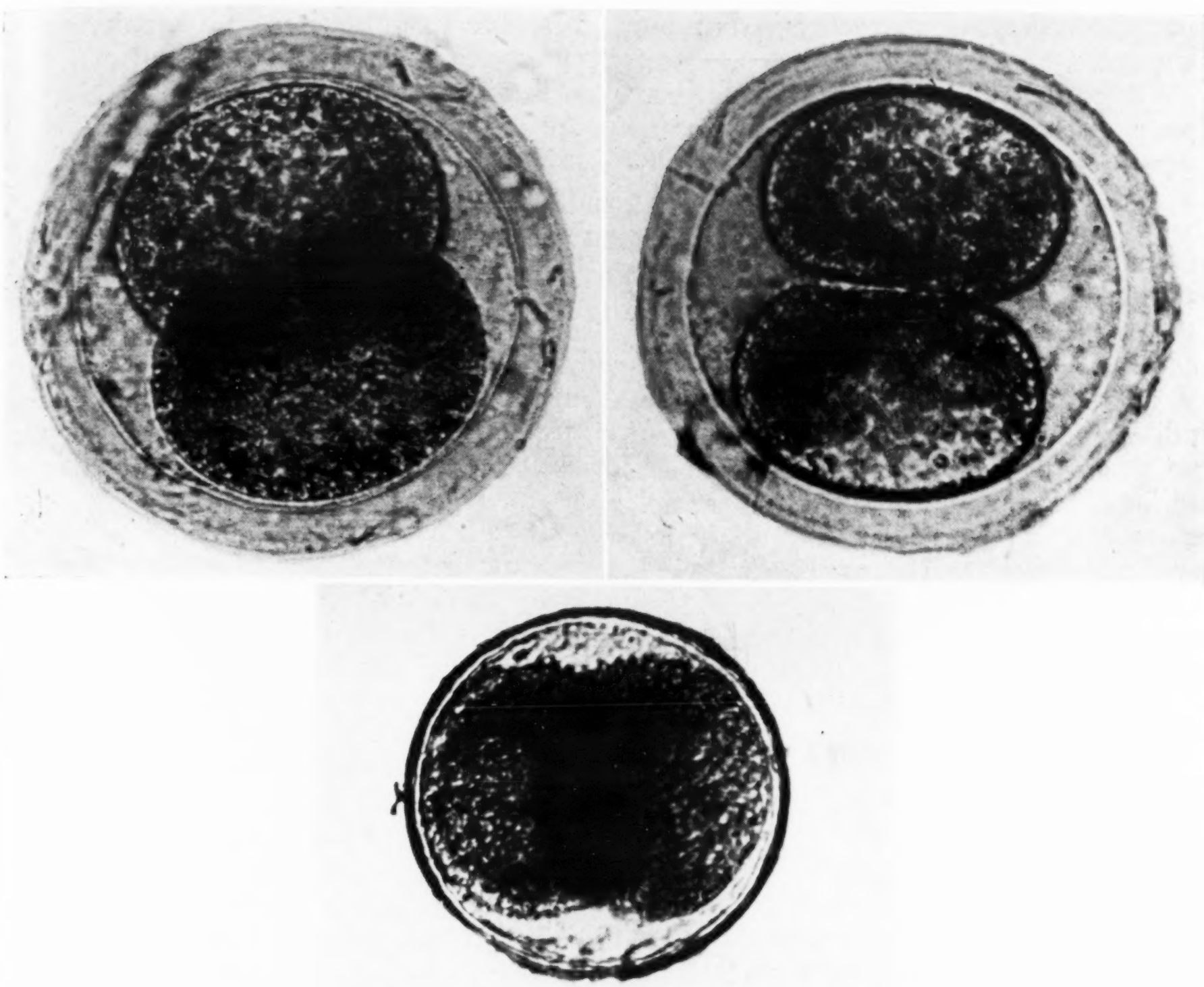
Figure 3

Two living rat's eggs, for comparison with the cow's eggs shown in the other figures. These eggs are somewhat smaller than a bovine egg, being enlarged about 600 times. Their appearance is such that they could hardly be identified as rats, although it might be possible to decide the eggs were not cow's eggs. A single spermatozoon is shown to the left of the lower egg. There are greater specie differences in sperm cells than in egg cells, and this cell can be seen to have very different proportions than the bovine sperm cells shown in Figure 2.

ERROR IN LEGEND TO FIGURE 3

The cut for Figure 3 is reversed, so that the text of the legend reads incorrectly. The sentence in lines 8 and 9 should read: "A single spermatozoon is shown to the *right* of the *upper* egg."

*This method of visualizing the size of cells in terms of a readily available measure was suggested recently by Dr. Edgar Anderson (*Science* 75: 359, April 1, 1932).



Photographs by C. G. Hartman & Warren H. Lewis

THE BRIDGE CROSSED—A COW IN THE TWO-CELLED STAGE

Figure 4

Fertilization of the egg has taken place and the new complement of chromosomes has initiated the complicated series of events which would eventually result in a new individual. Two views of the egg are shown as it appeared when it was recovered from its normal environment. The shrunken object below is the same egg after it had been placed in a preservative—emphasizing that the student of killed material does not see the same thing as the student of living material. The photographs are enlarged about 325 diameters.

The details of structure transmitted in these germ cells determine the smallest characteristics of the offspring, such as nicks in the edge of the ear, shape of the udder, amount of milk produced, etc. The genes carried in egg and sperm determine whether the resulting calf would have been a Holstein or a Jersey, whether it would have been horned or polled, black, red or roan. Whether the resulting calf would have been a bull or a heifer would be determined by the sperm cell which penetrated the egg, for half of them produce females and half males, the eggs being all alike in their sex-determining potentialities.

It seems a great pity that the profound importance of this universal bridge of life should not have taken a larger place in the consciousness of the race, for a clear understanding of its tremendous significance is a necessary first step toward the production of the selected, super races of mankind which will, if the race survives man-made obstacles to the perpetuation of his own species, some day inhabit the world.

matin, the material that actually transmits the inherited characters from one generation to the next.

While the sperm cell is relatively "pure heredity" it doubtless contains some waste material. The British biologist, Haldane, has pointed out that the chromosomes of the entire human race in the single-cell stage could be put in a thimble with ample space to spare. In this thimble would be all racial differences, all potential genius and imbecility, all the differences in eye, hair, skin, and teeth which are passed on from one generation to the next—all the hereditary talents and afflictions which belong to our race. All of these, in being transmitted to the next generation, pass through this one-celled stage, which must be so greatly magnified merely to enable us to *see the outside* with the human eye!

Size of a Gene

Even the chromosomes, small as they are, are by no means "pure heredity." Muller has likened the structure of the cell and the chromosomes to that of a city. From the point of view of mass and volume the buildings, streets, and bridges make up by far the greater part. The all-essential *people* represent only a small fraction of the total volume of the more imposing structures surrounding them, but of which these same insignificant individuals are the architects. Similarly the all-important gene represents only a small fraction, not only of the cell, but probably of the chromosome as well. We have progressed beyond the point discussed by the Athenians—the priority of owl or egg. As Weinstein points out, we realize today that eggs not only make owls and hens and humans, as a convenient way of making more eggs, but genes use the amazingly complicated living structures which we are, and which we see about us, as the most satisfactory way they have found to make more genes. It is these ultimate tiny particles of living matter that control the entire course of life. The eggs of a cow, an elephant, a giraffe, and a human perhaps could not be told apart by microscopic examination. Given the proper conditions the genes within them will differentiate the eggs and give us the organisms familiar to us in Natural Histories. Alter the genes and the animal changes, but known alterations of environment will not have any significant effect in making an elephant's egg turn out a mouse or a marmosat as an end product. In spite of all that has been claimed for the power of the environment, the only way to prevent an elephant's egg from fabricating an elephant is to destroy the egg. Nothing less will do.

Just how large are these vitally important potentialities, the genes, stored away in so tiny a space? By computing the volume of the chromosome and by dividing this figure by the minimum number of genes, which number is probably much too small, we arrive at a maximum size for the gene. Muller has computed that on this basis a gene would have a diameter not greater than one sixteenth of a micron, and probably much less. Muller has also called attention to the fact that ordinary concepts of cell division fail to apply when we consider the reproduction of a gene. A cell grows to a certain size —swells, we ordinarily say—and then divides, with an attendant longitudinal splitting of the chromosomes somewhat analogous to what happens when a "zipper" is "unzipped." The resulting daughter cells and daughter chromosomes increase to normal size and the process is repeated. In the case of the genes the concept of swelling and dividing falls down, and we must visualize a more intricate and exact mechanism.

The copper half-tone plates with which the illustrations accompanying this article are printed will make up to 50,000 replicas of the illustrations etched in hills and valleys on their surfaces. By that time the details would begin to fade out, until, if the number of impressions be tripled or quadrupled only smudges would remain. Other examples of replica-formation, more

persistent than this, might be cited in industrial processes. None are known which equal in accuracy the replica-formation which genes regularly display, *where exact replicas are made by the million*. Here is a process that cannot be fitted into the ordinary concept of "swelling" and the formation of a cell wall.

It is hard to think of the process of gene duplication as being carried on by a group of molecules. It is of a nature that can be most readily rationalized if we consider the process to be carried on by a single unique molecule. Some of the forces operating in a cell are not of a kind known to physics. Chromosome behavior at cell division and in the formation of sex-cells shows "likes" attracting at one time and repelling at another. Thus, it is not altogether fantastic to consider that this gene-molecule of a definite atomic pattern is able to draw from the surrounding medium the constituent atoms necessary to make another molecule of exactly identical arrangement. If this is a true picture of what happens the gene is unique in its ability in replica-formation for, on the average, a million or more "impressions" are produced without any visible alteration in the resulting "product."

When, the one time in a million, the pattern is not exactly reproduced, a mutation is the result. This new atomic arrangement may go on reproducing itself exactly and indefinitely. At the same time the old pattern is continuing to be produced by the gene-die that made the mutant error. In all the world about us there is hardly a more amazing example of a precision of mechanism than this, and in a field where it is ordinarily thought that a vague hit-or-miss process can be considered an adequate explanation of the processes of cell reproduction.

A decade or so ago geneticists were content to describe the end-product of gene action, the "finished character" in the adult organism. Modern tendencies in research reflect the unsatisfactory nature of this method. More and more effort is being concentrated on following through the activities of the genes, from the time they initiate their activities in the fertilized egg cell, to the final appearance of the adult characteristics. As yet, however, only a beginning has been made in a real understanding of these processes. We know, for instance, that the lethal "creeper" gene in fowls does not appear to affect the early development of the embryo, but kills during the third day of development. We know of other genes whose lethal effects are not manifested until birth or even later. Even in many of these relatively simple cases we yet know practically nothing about *why* these genes are incompatible with continued existence. In this fascinating and important field of what might be called gene-ontogeny a beginning has been made—nothing more.

Miracles of old, even the miracle of resurrection, are hardly to be considered more amazing than this continuing miracle of every day—the resurrection of life from the separated and supplementary halves necessary to initiate this wonderous process of growth and differentiation. Is not this passage through the early stages of growth amazingly like the passage of the Valley of the Shadow of Death? From the complex forms of life today, back to the first primal cell, the invisible bridge extends—over the Valley of Oblivion—unbroken.

ROBERT COOK.

From Egg to Egg

DAS DETERMINATIONSPROBLEM IN ANALYTISCHER DARSTELLUNG, by Adolf Cohen-Kysper. Abhandlunmen zur Theorie der organischen Entwicklung, No. 5. Pp. 48, Rm 4.80. Julius Springer, Berlin, 1930.

This compact sketch outlines the current answers to the question, why does a fertilized egg produce what it does produce, and how? It goes, therefore, to the very heart of genetics.

PAUL POPENOE.

Anthropology for Sociologists

THE MAKING OF MAN, AN OUTLINE OF ANTHROPOLOGY. Edited by V. F. CALVERTON. Pp. vii + 379. The Modern Library, New York, 1931.

THE book is a small octavo with thin leaves, narrow margins, and rather flexible board covers, which will fit one's side pocket, if desired. It is a compilation of standard Anthropological literature.

The editor wrote the introductory chapter which is entitled "Modern Anthropology and the Theory of Cultural Compulsives." He here stresses the informing idea of the book that man is a product of the culture of his social group in all matters except those of biological heredity. He might have added with equal truth that in hereditary biological factors many groups of men are also largely the product of their cultures, because the dominant social forces of artificial selection of mates has produced in some tribal groups, as the field Anthropologist knows them, quite as distinct "breeds" of people as domestication of animals has produced "breeds" of domestic animals. The editor also stresses the fact that Westermarck's theory of marriage has now been battered down by the data published by Briffault—to whom the volume is dedicated.

The volume contains a chapter of five papers on "Fossil and Prehistoric Man." The second chapter is composed of two papers on "Race and Language." The third has fifteen articles on "Social Organization." The fourth is entitled "Sexual Customs and Social Practice" and carries six papers. There are six articles in the fifth chapter entitled "Religion." And there are five short articles in the sixth and last chapter named "Evolution of Attitudes."

The selection of material reprinted in the compilation is quite as good as could be expected in so extensive a field as covered. If the articles on fossil and prehistoric man had been left out, and if there had been a section devoted to economic life, the goal of the volume would have been reached better and with more singleness of aim.

It would have been possible to have summarized the findings of the various articles reprinted. I believe such a summary, say as a last chapter of the book, would have been proper and of great value to students.

The editor definitely says the book will have served its purpose if it "helps social scientists . . . get a better and more informed and various idea of the nature of primitive man and the theories concerning him." Though I hold no brief for the Department of Sociology in the University where I reside, yet I am certain Minnesota Sociologists are much better informed in the Anthropological field than the editor believes American Sociologists to be.

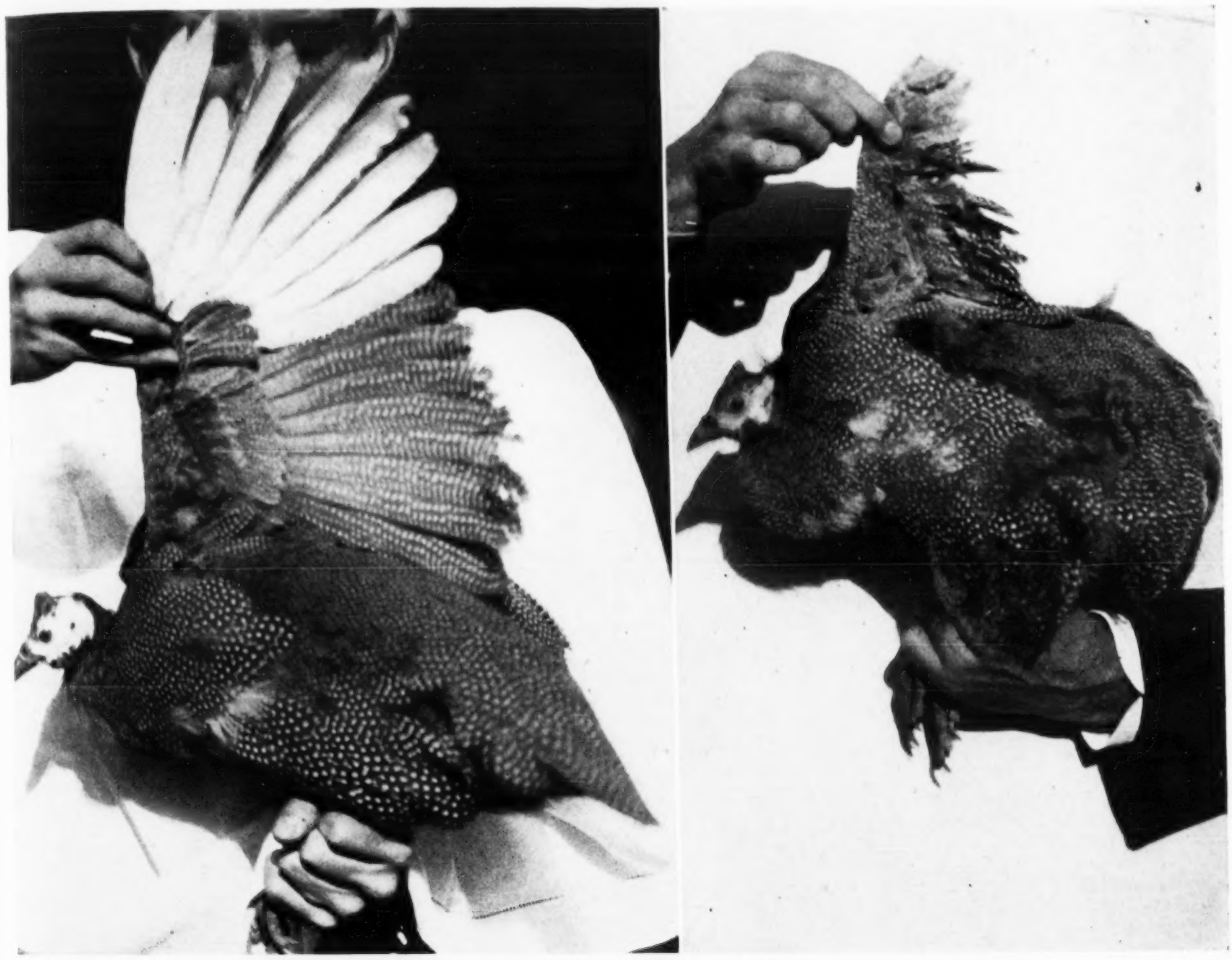
The book has no index—which, of course, all scientific books to be used as tools should have. Why an editor of the experience with which *Who's Who* credits Mr. Calverton could have decided that his book would have full student use without an index, detailed table of contents or an analytical summary, is a mystery to me. There is a short standard bibliography, and good foot-note references follow most of the chapters. The book should be of value to Sociologists, both instructors and students, because it has assembled so large an amount of Anthropological data necessary as a foundation for Sociology. I wish also that it might interest more Sociologists to leave the easy chair and take pot luck with field Anthropologists.

ALBERT ERNEST JENKS.
University of Minnesota

THE "PENGUIN" GUINEA FOWL

Absence of Flight Feathers Due to Hereditary Local Alopecia*

EDWARD MCCRADY, JR.
Wistar Institute of Anatomy and Biology, Philadelphia, Pa.



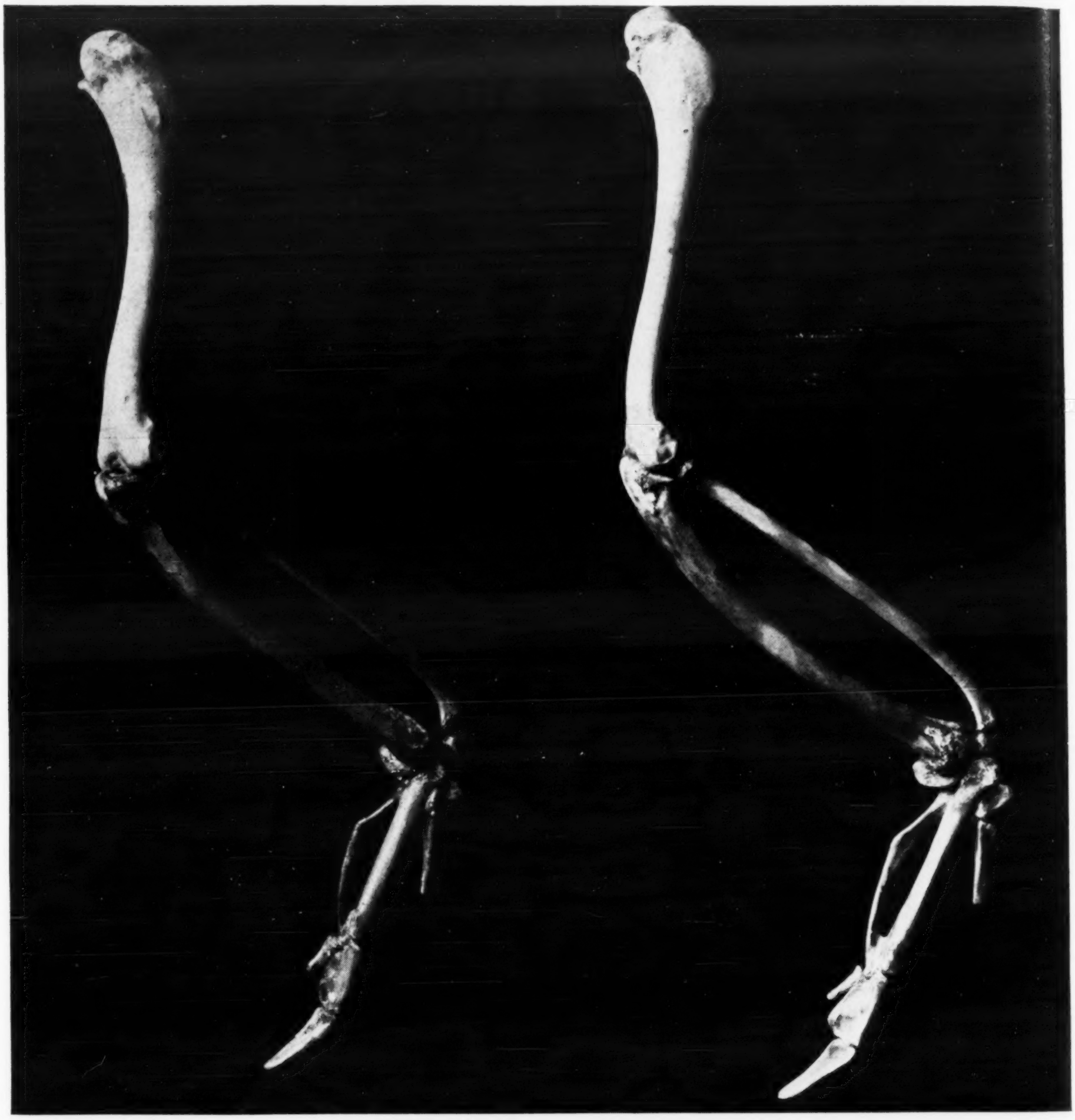
A "WINGLESS" GUINEA

Figure 5

At the right is a normal guinea cock nine months old; at the left a "Penguin" cock of the same age, and photographed at the same scale as the other. Note that the flight feathers of wing and tail are missing; otherwise the plumage is normal. A slight skeletal defect may also be produced by this gene (Figure 7).

IN the Spring of 1930 three cocks and three hens of the Guinea Fowl (*Numida meleagris*) were brought from Fairview Farm near Bristol, Pa., to the adjoining Bolton Farm. These animals were phenotypically normal in every respect. Being monogamous they were segregated into three pairs. After mating in April two of the pairs produced nothing but normal offspring. The third pair produced a brood of twelve, four of which showed a striking peculiarity which the farm manager noticed and described as "winglessness." In the Autumn of the same year two of the

* I have referred to the condition to be described in this paper as Alopecia after the precedent of C. H. Danforth[1], who in 1928 used the term to apply to a feather defect for the first time. However, the term is too broad to apply specially to the character here concerned, and so another name is proposed for this purpose in the course of the paper.



WINGS OF NORMAL AND "PENGUIN" GUINEAS

Figure 6

Skeletons of right wings of guinea cocks, that of the "Penguin" mutant at left and of a normal cock at right. The "penguin" gene affects only three rows of feathers on the edge of the wing, and homologous feathers in the tail. The wing bones are not affected. The mutation is not in any sense "winglessness" though the birds are so called on account of their peculiar appearance.

four were killed by accident so that no information can be had concerning their sex, but of the two surviving, one was male, the other female. It was at this time that I heard of the peculiarity. I examined the male of the pair closely, and found that instead of being a true amelus or phocomelus, it exhibited a peculiarity of a new type in which the remiges, the long feathers of the wings, and the rectrices, the corresponding feathers of the tail, were absent. The wing proper was present and apparently normal, though when not extended it was considerably covered up by the contour feathers of the body. One would not suppose on first thought

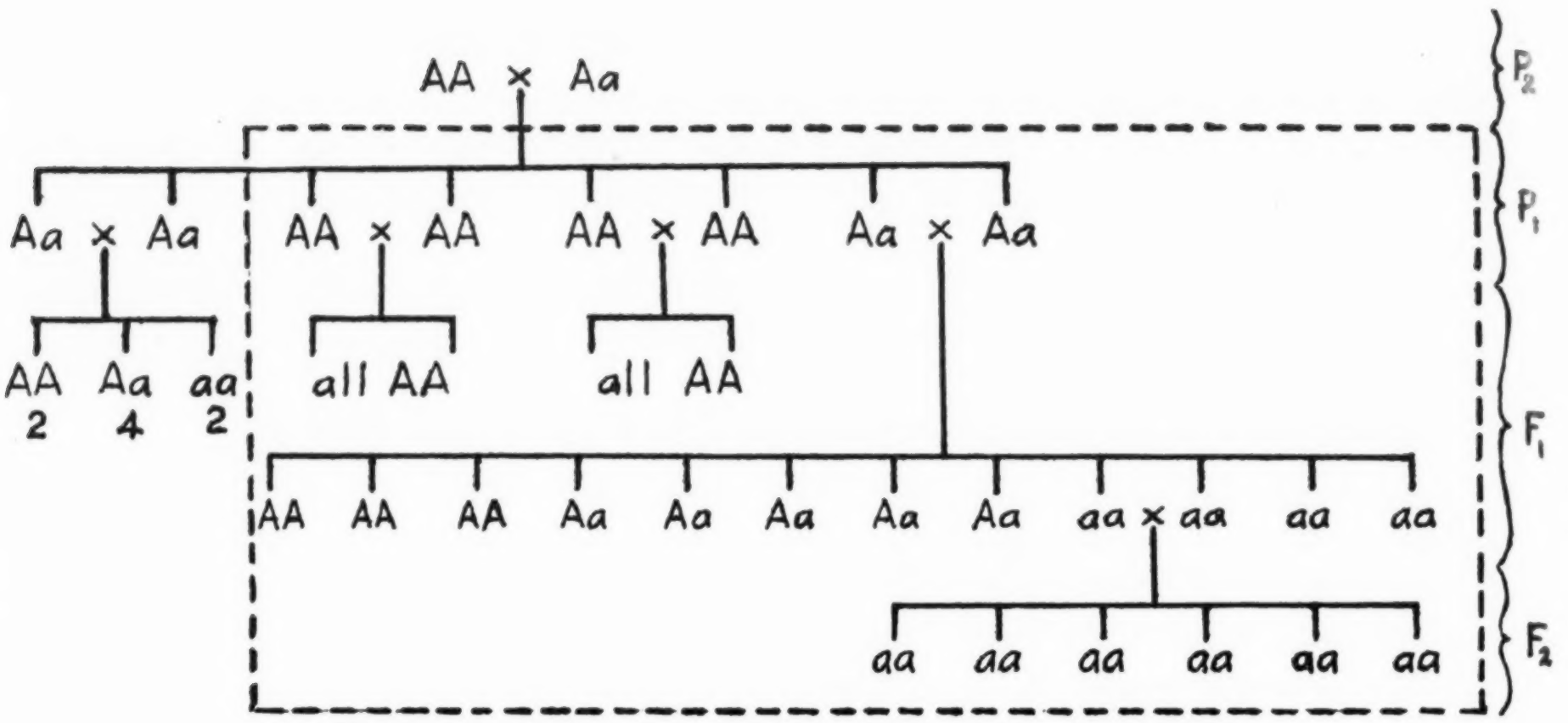
PELVIC BONES POSSIBLY AFFECTED

Figure 7

The caudal vertebræ of the "penguin" guinea cock (left) show definite abnormality, as compared with normal (right). The small number of individuals available has made it impossible to carry on further dissections, and until this is done it cannot be finally concluded that this is another manifestation of the same "penguin" gene which affects the flight feathers.

that the absence of the flight feathers could make so extraordinary a difference in the appearance of the bird; but actually when the wing is not extended, it is easy to understand how such an individual could be thought to be entirely wingless, and even when the wing is extended it seems disproportionately short as Figure 5 will bear witness. I shall reserve the more complete description of this specimen for another section of this paper.

Since there were only two of these anomalous guineas alive in the autumn of 1930, it seemed advisable to mate them to one another, with a view to preserving the stock, if the anomaly should prove inheritable, and also, in this event, gathering the first data for the analysis of the genotype. They were allowed to run together



INHERITANCE OF WING AND TAIL DEFECT

Figure 8

The individuals designated as *Aa* in the F_1 are phenotypically normal, and their heterozygosity has not been tested by breeding. All other data in the chart have been definitely ascertained. The dotted rectangle separates the Bolton Farm group (inside) from the Fairview Farm group (outside).

all winter. The male showed some aversion to the queer looking hen, and seemed to prefer to mate with a normal one; but not being given opportunity for this, in April, 1931, he mated with her. Many eggs were laid, but only six hatched. Four of these died before maturity; two are still alive at the time of writing.

Meanwhile two more mutants of the same sort have appeared on Fairview Farm, the original home of this stock. An examination of their ancestry shows that they belong to the generation (designated F_1 in the Chart) corresponding to that in which the first mutants appeared on Bolton Farm, and that they had the same grandparents.

All the specimens have now been removed to the Morris Biological Farm of the Wistar Institute, where I am continuing breeding tests with them. However, from the data given above it is already possible to make a fairly conclusive analysis of their genotype.

Interpretation of Breeding Data

The fact that the peculiarity appeared for the first time in six members of one generation indicates either that the mutation causing it took place six times separately and simultaneously, if heterozygous, and twelve times, if homozygous; or that it took place in a previous generation. Since the F_2 breeding data show that it is homozygous, it would be necessary in this instance to assume that it had occurred twelve times according to the first of the alternatives. However, as mutations under normal conditions are at best rare, and identical mutations even rarer, the simultaneous and independent occurrence of twelve identical mutations in one generation is certainly exceedingly unlikely. But if the second of the alternatives be the correct one, i. e., if the mutation took place in a previous generation, the new gene is necessarily a recessive; inasmuch as it did not express itself phenotypically in any members of the parental generation. Furthermore, it can not be located in the sex chromosome, for, if it were, even though recessive, it would have shown itself phenotypically in the digametic parent (in fowls the female). Since, then, it did not appear at all in the parental generation, and appeared in six individuals simultaneously in the first filial, and bred true in the second

filial, we must assume that it is an autosomal recessive, and that the individuals that show it are homozygous.

If, with these data in mind, we designate the mutant gene *a* and its normal allelomorph *A*, we can chart what we believe to be the case as is shown in Figure 8.

It will be seen from this chart that the expected ratios are very well fulfilled. In the P_1 the progeny of $Aa \times AA$ are all normal in appearance, and show an exact 1:1 ratio of homozygous and heterozygous individuals as proved by breeding. The fact that the heterozygotes in this generation bred with each other and not with homozygous normals was due to accidental good fortune. In the F_1 from $Aa \times Aa$ in the Bolton Farm group the ratio of normal phenotypes to mutants is eight to four, or two to one, instead of the expected three to one. But, of course, if a single one of the *aa* had been *Aa*, a perfect three to one ratio would have resulted; so the discrepancy is probably due to sampling in small numbers. In the Fairview Farm F_1 of the same cross an exact 3:1 ratio is realized. In the descendants of all $AA \times AA$ matings the expected 100% normals was realized. And also in the F_2 progeny from $aa \times aa$ only the expected 100% mutants appeared.

Discussion

It now remains to describe the anatomical peculiarities of this mutant in more detail, and to compare it with related mutations in poultry.

Though the lack of the long feathers makes the wing look so small that it suggests phocomelia, or at any rate ectromelia, dissection shows that no such condition is present. Phocomelia and amelia, the complete absence of the limb skeleton, are both known in chickens. Kirkham and Haggard[7] in 1915 described a wingless rooster, and showed by breeding tests that the condition was not genetic. They assume that it was caused by abnormal temperature variation in the incubator, and cite one case of a wingless hen possibly affected by the same factor. Terry[14] in 1919 described another wingless hen. In each of these cases there was no wing skeleton present at all, and the condition was a non-hereditary developmental anomaly. I believe there has never been described a case of hereditary amelia.

Of more interest in connection with these guineas is the work of Landauer[4, 10, 11] and Dunn[4, 10] on the Creeper Fowl. In this instance we are dealing with a definitely hereditary phocomelia. The condition is inherited as a simple autosomal dominant which is semi-lethal and cumulative in its effects—that is to say, the peculiarities are more pronounced in the homozygous than in the heterozygous individuals. As an instance of this, the heterozygotes are less viable than normals (more heterozygotes fail to hatch than normals), but the homozygotes are 100% lethal. Most of these lethal embryos die at a critical period around 72 hours after fertilization before the limb buds have developed far enough to show any peculiarities. A few survive until the time of hatching, but do not hatch. These latter have decidedly phocomelous limbs.

It was with a view to comparing the wing defect here described with that of creeper fowls that I made dissections of the limb skeletons of a mutant and a normal guinea. I find that in the present mutation there is no apparent abnormality of either the leg or wing skeleton. Figure 6 shows a photograph of wing skeletons taken from a mutant guinea (left) and from a normal guinea (right). It will be seen that all the bones present in one are also present in the other and are approximately equally developed.

The situation in the caudal skeleton is not quite so certain. Figure 7 shows very well the abnormal appearance of the mutant guineas with respect to the rump. This suggests an affinity to hereditary rumplessness and hereditary intermediate rumpless-

ness as described by Landauer[8, 9] and Dunn[2, 3, 8]. Pictures taken from their dissected specimens show that in rumpless fowls some or all of the caudal vertebrae are lacking in each case. Those in which all the caudal vertebrae are absent belong to the true rumpless group, and those in which the reduction is not complete belong to the intermediate rumpless group. In this latter group the synsacro-caudal vertebrae are always lacking; the five free caudal vertebrae are usually present but much reduced and fused with one another in various degrees; and the pygostyl, though present, is composed of fewer embryological elements than is normal. I find on dissection of these mutant guineas that the normal number of synsacro-caudal and free caudal vertebrae is present. However, it may be seen from Figure 7 that the pygostyl is very decidedly reduced. Whether it is composed of fewer embryological elements; whether these elements are of smaller size; or whether, indeed, it is always as abnormal as in the case photographed, remains to be determined. We have so few of the mutant guineas alive that we can not afford to kill them at random for dissection. And they breed so slowly that it will be several years before we can have them in sufficient numbers to make all the desired crosses and still have some for dissection. The most that we can say at present is that in addition to its ectodermal expression the new gene apparently extends its influence to the skeleton in the caudal region reducing the pygostyl.

There are many known genes affecting feathers. Most of them influence color pattern[5], rate of feathering[15], structure of feathers[11, 12], etc., but there are two that show some similarity to this new mutation. I refer to the gene for the "frizzled" character[12] and that for absence of the hackle[6]. The gene "frizzled" not only modifies the fine structure of the feather very radically, but also in the homozygous condition affects the distribution of the feathers, leaving large normally feathered areas unfeathered. Since the gene I describe leaves two normally feathered areas unfeathered it bears in this respect some similarity to it. "Frizzled" is an autosomal dominant, and in the homozygous state impairs fertility and viability. The gene "hackleless" is even more similar, inasmuch as it affects the feathering of a smaller and more constantly defined region, the neck, preventing the development of the feather follicles in that region. The neo-Lamarckian view that it may be caused by the inheritance of acquired dermatitis erythematosa has been expressed, but this seems to have been definitely disproven by Greenwood[6] who showed that it is due to a dominant autosomal mutation. This mutation differs from the one here described in being dominant rather than recessive; in affecting the neck region rather than the ulnar border of the wing and the edge of the uropygium; in having no skeletal effect; and in causing a highly vascular condition in the denuded area which gives it a red appearance to which there is nothing corresponding in these guineas.

In the new guinea mutation I have found no abnormalities of the feathers in any region other than the two mentioned (ulnar border of the wing and the edge of the uropygium). In these bare areas the feather follicles may be seen, but the development of the feather above the skin does not usually complete itself. In one instance in the F_2 three of the remiges, two on one side and one on the other, are present above the skin, though imperfectly developed. In all other instances they are entirely lacking externally. The adjoining rows of feathers on either side, the upper and under coverts are present and normal both on the wings and the uropygium. Only two rows of feathers (three if you count the right and left remiges separately), the ones constituting the flight feathers, are absent. It is this strict and narrow confinement of the effect of the new gene which makes

the term alopecia too broad and unspecific. For this reason, I propose the name aprotopteria for this condition. Whether the mutation causing aprotopteria* has occurred before historically, whether, for instance, it played a part in the evolution of the Ratitae, the flightless modern birds, is a matter of speculative interest. In all of these the "rectrices are absent or irregularly arranged, and the pygostyl is small or undeveloped"[13].

One other detail in the breeding data deserves attention. The frequency of lethal or semi-lethal effects of mutations in poultry makes one look with suspicion at the small number of aprotopterous guineas which have survived to maturity, and the large number of eggs laid by the F_1 female which did not hatch. Unfortunately these eggs were not opened to see whether they contained lethal embryos. This observation will be made on the eggs laid in the crosses now in progress. As for the homozygous mutants which hatched but did not survive to maturity, it may be said with certainty that the two in the F_1 died by accident. They were eaten by a dog. But for the four in the F_2 there is no explanation, and one must hold them in suspicion.†

Summary

1. A new mutation, aprotopterous, preventing the development of the flight feathers of the wings and tail, and apparently reducing by nearly 50% the size of the pygostyl, has appeared in the guinea fowl (*Numida meleagris*).

2. The new gene is an autosomal recessive.

3. There is some basis for a suspicion that it impairs viability.

4. It is suggested that a similar mutation may have played a part in the evolution of the flightless birds.

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* From the Greek: a—lacking; protos—primary; ptera—feathers. It will be remembered in this connection that the original meaning of pteron is feather, not wing. The forms, aprotopterus (noun—an individual exhibiting the condition) and aprotopterous (adjective—pertaining to the condition), which with their Latinized endings are really linguistic hybrids, I feel constrained to adopt after the almost universal Medical precedent in such words as amelus, phocomelus, ectromelus, and their adjectival forms.

† I am indebted to Mr. Effingham B. Morris, President of the Wistar Institute, for the gift of the guinea fowls described in this paper; to Mr. C. G. Dietrich, Manager of Bolton Farms, for the information of their first appearance; and to Mr. P. R. David of the Storrs Agricultural Experiment Station for many and valuable references to the literature.

GENIUS AND HEREDITY

A Review

THE literature on genius is very meagre. We know very little that is fundamental about that rarest type of man who is of utmost importance to humanity. The reason for this is perhaps, as Dr. Hirsh states, "that no final study of genius is possible until a genius writes upon the Nature, Position and Problems of Genius."

This book* is divided into three main parts. Part I, "History, Creative Adaptation, and Genius" (64 pages) discusses "the nature of Man by succinctly analyzing his socio-historical development, his methods and means of adjustment, and some of his future possibilities in this direction." Part II (191 pages), seeks to understand and interpret Man by analyzing his psychological constitution. Part III (55 pages), is devoted to the nature, function, and singularity of Genius.

After revewing man's types of adaptation to his environment such as passive physical and social adaptations, active physical and social adaptations, Dr. Hirsch concludes that there is an urgent necessity for a new type of adaptation termed creative adaptation which he divides into (1) positive eugenics, (2) negative eugenics, and (3) birth control. He believes that a hopeful asset with which to face and overcome world-wide racial retrogression is our knowledge of the principles of biology and heredity:

> Never before have so many of the facts and principles of variation, heredity and selection been known; a Freshman course in biology gives the student more information than the greatest naturalist possessed a century ago. But can our knowledge be turned into power—our knowledge of the kinds and conditions of variations, the modes of transmission, etc?
>
> The biological situation of mankind today is unique in two important ways. First, never before have there been a number of currents all converging in the direction of national and racial amalgamations. Previously, the decadence of a civilization and its consequent submergence were only a social and national disaster; the vigorous barbarian *supplanted* the representatives of the dying civilization but *assimilated* the civilization. But today, if the civilized nations succumb, because of the exhaustion of their most vital element, superior blood, there are no new hordes to supplant them. A race of mongrels, morons, and maniacs, is the displeasing possibility, if the present tendencies of differential, racial, national, and class birth rates are not *reversed*.
>
> Beauty, with intelligence, character, and initiative is declining. The supremacy of the under-man appears possible; and if so the death knell of civilization is almost within hearing.
>
> The necessity for Creative Adaptation reveals itself in the realm of beauty, as in governments, economics, education, religion, and science. An insurmountable disjunctive situation faces the world today: either Creative Adaptation or a return to barbarism.

Dr. Hirsch makes these conclusions only after a careful and dispassionate survey of facts which he ably summarizes. Civilizations decay largely because their human harvests are bad, according to Dr. Hirsch, and war is one of the fertile agents for the propagation and multiplication of the less fit.

> Rarely if ever before in history has there been such a wealth of great opportunities, such a crying need for great men, and such a dearth of them as has characterized the world in the last fifteen years. The most titanic of situations—the most volcanic events—the daily eruptions that formerly took years or decades to witness, occurred in the midst of a human, living drought. History was and is being manufactured—the hand-and-brain-making of history has temporarily ceased. Second-rate military leaders, and third-rate naval men, statesmen and diplomats are pawns in the movements that be.

The author believes that the decline of the birth-rate is in itself no evil. Recent surveys seem to indicate a decided trend of opinion in this direction.

> The deplorable state today is not the decline, but the differential decline of the birth-rate. The less fit in each nation are

*GENIUS AND CREATIVE INTELLIGENCE, by Nathaniel D. Mttron Hirsch. Cambridge, Mass. Sci-Art Publishers, 1931. Pp. 339. $3.00.

propagating at no less a rate than a hundred years ago, and the lessened death-rate multiplies their numbers continually; on the other hand, the most fit do not reproduce their numbers and the lessened death-rate cannot effect nearly as productive results as with the first-mentioned type. Furthermore, the most civilized and most progressive nations are suffering from this worst of all human maladies at a higher rate than the countries of Eastern and Southern Europe.*

Intelligence is divided by the author into three kinds: "The first dimension of intelligence" which corresponds to instinctive behavior; "the second dimension of intelligence" found in man alone having for its motor mechanism some form of language or some external object such as tools or machinery in contrast with the first dimension which utilizes the animal organism; "the third dimension of intelligence" or creative intelligence.

The Third Dimension of Intelligence, like the first two kinds of intelligence, has three aspects or phases. The cognitive aspect of the highest dimension of intelligence we shall term "intuition." The conative aspect of this dimension of intelligence is the impulse to Create, which in artists, scientists, inventors, and philosophers of the first magnitude is more persistently present and more imperiously impelling than the instinctive drives of the ordinary man. The affective phase of the Third Dimension of Intelligence is the emotional experience of Ecstasy.

The Third Dimension of Intelligence has likewise its motor mechanisms. *Some of* these motor mechanisms are (1) Language, as utilized in poetry, drama, and other forms of literature, and as the vehicle of expression in original systems of philosophy, in great religious teachings and in profound and epoch-making works of science; (2) The material that sculpture, painting, and architecture utilize in creation; (3) The symbols of logic, mathematics, and music; (4) The tools and machinery used in the inventions and discoveries of the sciences; (5) The human body as the instrument of the fleeting creativity of acting and aesthetic dancing; (6) The human bodies and groups of persons employed by the military genius and political genius.

The different aspects of the three dimensions of intelligence are carefully analyzed. Many biological, anthropological, and psychological viewpoints are brought to bear on the problems involved. The author gives us an excellent survey of the existing theories relating to creative intelligence and genius, which is a distinct contribution to the subject.

In regard to genius he states:

The conclusions reached by writers and investigators in the last three-quarters of a century may be classified roughly into three broad groups: a negative view of genius, in which genius is biologically linked with insanity, degeneracy and imbecility; a positive view of genius which discovers its affinity with normal humanity, genius merely being an enlargement and quantitative increase of the faculties common to the average man (on this view, genius is superlative talent); a view which regards genius as qualitatively differing from talent, a phenomenon generally distinct from the extension of normal capacity. Genius, on this view, has a nature *sui generis*.

Dr. Hirsch defines a genius as "a person motivated by and frequently experiencing the functioning of creative intelligence." He has no patience with the shallow view identifying genius with insanity. Yet very recently this view is again championed in "The Problem of Genius" by Wilhelm Lange-Eichbaum. The best refutation of this view is that "the genius which runs to madness is no longer genius." It is the supreme sanity and not insanity

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* The editor of *New York Times* (May 1, 1932) observes:

Not so long ago the program consisted chiefly in scolding the "unfit" for having too many children. This line of attack has been rendered obsolete by the fact that the masses everywhere, except in Japan, Italy and Russia, have been converted with a vengeance.

How to "sell" the four-children family to teachers, doctors, lawyers, business men and the like is the crux of the problem. The basic reason for a falling birth-rate nowadays is not economic, as among primitive peoples. The birth-rate sinks as living standards go up. Increased well-being regularly encourages escape from the responsibilities of parenthood and toward a "fuller" individual life for the parents. This is why families grow smaller as income increases and why in virtually every country the birth-rate goes down as the national income goes up.

of genius which has given mankind their gifts.

The author concludes:

The genius differs in *kind* from the species, man. Genius can be defined only in terms of its own unique mental and temperamental processes, traits, qualities, and products. Genius is another psycho-biological species, differing as much from man, in his mental and temperamental processes, as man differs from the ape. As to outward garb, his vesture resembles that of all men, varying as they do from climate to climate, from age to age, and varying also as men vary within an age and territory. But these are garbs and vestures *externally* relating him to the talented and to the imbecile, and to the neurotic and to the stable. Beneath, when we approach the inner parts and envisage genius unclothed, naked to the rays of the sun, lo, we behold another species, novel, fascinating, godly, a physical mutation which lacunizes nature as the birth of the butterfly from the caterpillar.

Geniuses are born, not made. Environment's and nurture's chief rôle in the lives of genius has been the negative one of truncating their lives and curtailing their creative work. Environment cannot produce genius but it can destroy him. As eating does not produce thinking but is a necessary condition for mental activity, so the social milieu of a genius is related to his creative gleam.

There is a wealth of data assembled in this volume. Dr. Hirsch, as he has already demonstrated in his previous volume "A Study of Natio-Racial Mental Differences," has an unusual ability to organize, classify and evaluate numerous facts and theories bearing on every phase of the problems under consideration. He is a tolerant psychologist who is willing to accept what is helpful from any school of thought, be it behaviorism, Gestalt psychology, psycho-analysis, or hormic psychology.

Joseph Rossman.

U. S. Patent Office.

The Feeble of Mind

THE MENTAL DEFECTIVE. Berry, R. J. A., and Gordon, R. G. New York, McGraw-Hill Book Co. 1931. Pp. XIII + 225.

THIS book aims to present an epitome of "the real achievements made in the recent study of mental deficiency and the underlying underdevelopment of the growing brain." As is pointed out in the preface, a large number of people are now called upon to deal in some capacity with mental defectives, and it is desirable that authoritative knowledge on the subject be readily available. Hence this volume.

The first chapter on "The Problem of Mental Deficiency," sets forth the extent of mental deficiency in Great Britain, the operation of the Mental Deficiency Acts, and the social, educational, and economic problems which mental deficiency creates. The following two chapters on "The Evolution of the Brain" and "The Making of the Mind" present many facts of anatomy and physiology which, for the most part, are not very closely correlated with the general subject matter in hand. Had these chapters been omitted and the space, about a third of the book, been devoted to giving more information about mental deficiency, the volume would have been much more useful.

Chapter V deals with the various classes of defectives, and chapter VI with the relation of mental defects to other forms of illness. The last chapter is concerned with how mental deficiency should be dealt with. The authors are not sanguine in regard to the eventual elimination of the burden; "it is much to be feared that such a task is beyond our power." We must, therefore, put up with mental deficiency indefinitely. Sterilization appears to be classed as one of the "highly debatable procedures" which are mentioned but not further discussed. The ultra conservatism of the authors on this subject represents a quite typical English attitude.

S. J. Holmes.

University of California

SOME OBSERVATIONS ON THE TEACHING OF HEREDITY AND EUGENICS

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IT may be said that scientific research is without value until it is translated into acts to alleviate suffering and to advance civilization. This is as certainly true of the science of Heredity and Eugenics as it is of any other science.

Rapid strides are being made in the advancement of these two closely related sciences from the standpoint of research. However, it is our opinion that far too little is being done to carry existing knowledge along these lines down to the population as a whole. Information pertaining to what is probably the greatest problem facing western civilization is locked in the minds of a small group of enthusiastic workers in the field. Much is being done to advance these sciences technically but comparatively little is being done to correct the grave faults their study has brought to light.

With our characteristic custom of locking the barn after the horse is stolen, we may get the desired information to the public after most of the damage has been done.

With a race that is clearly breeding from the bottom, with that problem becoming rapidly more acute during the past decade, correct information on Heredity and Eugenics should be carried to the public now.

Our experience in teaching Heredity and Eugenics to junior and senior students in a teacher-training institution has led us to the conclusion that the thinking persons in our society are ready and anxious to receive this information.

Interest in the Subject

During the school year, 1929-30, we offered courses in Heredity to 297 students. Eugenics was offered to 119 students. This was a representative enrollment.

It should be borne in mind that the great majority of these students were not biology majors. They were taking the courses for their cultural value and for help in solving their teaching problems.

The courses are based upon the usual background of the chromosome theory of inheritance, Mendelism, mitosis, combination of inheritance factors, organic evolution, natural selection as applied to man, continuity of germ-plasm, biological immortality, etc. A careful study is made of the effect of assortative mating and the differential birth rate.

No effort is made to popularize these courses by making them easy. No laboratory work is done. We feel that in a course in Heredity carrying only two semester hours credit, we have so many big ideas to offer the students that we can not afford to have them spending their time attempting experimental work that any specialist in the field can do better than they. Extensive reading is required from the works of recognized writers in the field.

Objectives

We feel that we are generally successful in reaching the following objectives:

1. The student must have an active interest in Heredity and Eugenics.
2. The student must have a working knowledge of the fundamental theories of heredity.
3. The student must recognize the significance and importance of the continuity of the germplasm.
4. The student must recognize the

significance and importance of biological immortality.

5. The student should be "sold" on the idea of lowering the undesirable hump as shown on the differential birthrate curve.
6. The student should be "sold" on the idea of raising the desirable hump as shown on the differential birthrate curve.

Probably no other courses offered to our students create as much interest and discussion about the campus as do the courses in Heredity and Eugenics. We find that most students take a delight in the work. They readily grasp the significance of the present population trends.

Let's Let the Public In

After handling hundreds of students in these classes during a period of ten years, we reach the following conclusions:

1. A large part of our population has no conception of the part heredity plays in human affairs.
2. Many valuable family lines are approaching extermination without ever having their attention called to the consequences.
3. The idea of continuity of germplasm and biological immortality is new to most persons.
4. A large part of our thinking population is ready and anxious to receive information on heredity and eugenics.
5. The correct information properly presented will increase the birthrate of the better classes.
6. Active steps should be taken at once to present a correct and sane program of popular eugenic education to the public.
7. Naturally, we realize that the last word has not been said in these fields. However, if we wait until the last word can be said, it will be too late to say it.

WHY NOT LET THE PUBLIC IN ON OUR SECRETS?

▼

The Institute of Forest Genetics

The name of the Eddy Tree Breeding Station, at Placerville, California, has been changed to "Institute of Forest Genetics," according to an announcement from Lloyd Austin, director. The new name is believed to be more truly expressive of the character of work being carried on. Development of improved, rapid-growing strains of timber trees is a primary objective of the Institute. The early work of the Station was described in this JOURNAL in 1928.

In connection with the change of name, steps are being taken to place the Institute on a permanent basis. A non-profit corporation since its beginning, the institution is now being reorganized to provide for government by a self-perpetuating board of fifteen trustees, who are being chosen from among prominent foresters, geneticists and business men. Gifts for current expenses and for a permanent endowment fund will be sought in the near future.

The institute was established in 1925 by Mr. James G. Eddy, a Washington lumberman who had the imagination to see in Luther Burbank's achievements with domestic plants a key to the solution of the reforestation problem.

BUD VARIATION IN APPLES

A Study of the Rôle of Bud Mutation in Deciduous Fruit Improvement

A. D. Shamel and C. S. Pomeroy

(Concluded from the April Number)

Elimination of Undesirable Strains

In a recent study of young bearing Peach trees of the leading commercial canning varieties in an orchard of more than 3,000 acres located near Merced, California, many trees of undesirable strains of the varieties have been found. These off-type trees were first thought to have been of seedling origin but subsequent investigations have shown that some of them at least were probably grown from buds that were unintentionally cut from bud variations in the parent trees from which the buds for nursery use were obtained. In similar studies in Washington Navel orange orchards of California more than 25 per cent of the trees were found to be of undesirable strains that were the result of the unintentional propagation of inferior bud variations. In recent observations of several young bearing apple orchards located in the Wenatchee Valley of Washington some of the growers have reported that undesirable or off-type trees have been found in these orchards that are apparently the result of the use of buds from limb or entire-tree variations in the parent trees from which the buds were secured for nursery propagation.

In the citrus fruit varieties grown in the Southwest the unintentional propagation of undesirable strain trees from limb or entire-tree variations has been greatly reduced through the systematic selection of parent trees as sources of budwood for commercial propagation in which the fruits on all of the branches are consistently like those of the typical ones for the variety. This method of bud selection for the elimination of undesirable strains in the propagation of commercial varieties may be as possible for apples as is the case with the other species of fruits, where it has already been found to be practicable and efficient.

Healthy off-type trees of undesirable strains or of inferior varieties can often be successfully top-worked with buds from carefully selected good type parent trees. In some instances apple growers in the Northwest have reported that they prefer replanting the undesirable trees with dependable young nursery trees but the most generally used practice at this time seems to be top-working rather than replanting. In the case of undesirable limb variations in otherwise normal trees they probably can be eliminated through the cutting out of these limbs at the time of pruning if they have been marked while the fruits were still on the trees so that they can be subsequently identified.

Description of Several Striking Apple Bud Variations

In this progress report it is impracticable to attempt to describe any considerable number of the striking apple bud variations that are known at the present time. However, descriptions of a few typical variations will be presented in order to show something of their nature. Only the characteristics of the variations that most clearly distinguish them from the parent forms will be mentioned. These descriptions will be largely confined to fruit characters and in order to illustrate them photographs of a few typical fruits will be shown.

Starking. A limb of an otherwise normal Delicious apple tree in an orchard belonging to Lewis Mood located

near Mullica Hill, N. J., was found to bear apples that consistently developed a deep and almost solid red color two or three weeks ahead of the fruits borne by the remaining limbs. This tree with its limb variation, was called to the attention of a nurseryman who in 1922 purchased the exclusive right to propagate the limb variation. Progeny tests by the nurseryman proved that the characteristics of the limb variation were perpetuated through budding after which it was propagated commercially and sold under the varietal name of Starking. (This tree was shown in Figure 9 in the April number.)

The fruits of the Starking apples as grown in the Wenatchee, Wash., districts are mainly distinguished from ordinary Delicious apples by the earlier development of the characteristic red color with basic stripes and by the fact that in the case of the Starking the red color at the time of maturity is almost solid over the entire apple.

In shape and size characteristics the Starking apples appear to be identical with the parent Delicious apples. The texture, spicy flavor, and seeds of the Starking are very similar to those characteristics of Delicious grown under comparable conditions. Owing to the early coloring of the Starking apples they will usually be well colored when they have reached their optimum storage and dessert condition. It is important to allow them to mature before picking, otherwise an unsatisfactory product is likely to be obtained. When picked at the proper stage of maturity for storage and dessert qualities, the earlier coloring strains will usually grade a higher percentage of Extra Fancy or No. 1 fruit.

The foliage characters of the Starking trees appear to be similar to those of the ordinary Delicious trees but it is usually possible to detect on the Starking nursery trees a slightly darker color at the base of the leaf petioles and a somewhat darker color of the bark of the trees.

Richared. Another bud variation of the Delicious variety that is attracting wide interest among apple growers is one that has been propagated under the name Richared. This strain originated as an entire-tree variation in the orchard of Lewis Richardson located at Monitor, Wash. It is said to have been found in 1919 and progeny propagations of the parent tree were made in 1922 by a commercial nurseryman in order to find out whether or not its characteristics would be perpetuated through bud propagation. A top-grafted tree came into bearing in 1925. It was described in *Fruits and Gardens* for December, 1928. The success of the progeny propagation was followed by the commercial introduction of this strain under the variety name of Richared.

All available evidence indicates that the parent Richared tree is the result of the accidental propagation of a bud sport among the Delicious buds used in the propagation of the nursery trees with which the Richardson orchard was planted. In several other Delicious orchards near Wenatchee from one to five trees with more or less solid red color of fruits have been found which came from the same nursery the same season. These instances constitute additional evidence as to the origin of these entire-tree variations through the accidental propagation of bud sports of this nature.

The fruits of the Richared variation have a very deep and almost solid red color that begins to develop as a blush two or three weeks earlier than the red stripes on comparable normal Delicious apples. The color of the Richared apple is a very dark red, and differs sufficiently from that of the Starking to enable growers and others to identify the fruits of each variety with certainty in orchard and packing-house tests.

The shape and size of the Richared apples are about the same as those characters of the fruits of comparable Delicious apples. Owing to the early development of the red color on the Richared apples they are sometimes picked

before the Delicious fruits that have been grown under similar cultural conditions. In this instance, as is the case with the Starking, care must be taken not to pick the apples before they have matured to the point where they have developed their full flavor and best commercial qualities.

The foliage characteristics of Richared trees are apparently similar in most respects to those of the parent variety and the quantity of production so far as it has been determined is about the same as that of the Delicious variety. The commercial propagation and planting of the Richared variety, as is the case with the Starking, is being carried on in a number of apple growing districts of the United States, particularly in the Wenatchee section of Washington.

Staymared. A strain of the Stayman Winesap originated as a bud sport in a block of Stayman Winesap apple trees that was planted by the late B. C. Moomaw in his orchard near Covington, Va. It was first noticed about 1924 as a tree that possessed typical Stayman Winesap characteristics except that its fruit began to color earlier than the normal ones and at harvest time had a more attractive, darker red color than the normal Stayman Winesap apples in the same orchard or in other orchards in that part of Virginia. Not only was the color of the fruit an improvement, but it was also reported that the apples were not so subject to scald as the normal Stayman Winesap fruits. A careful study of the foliage and fruit characteristics led to the conclusion that the tree bearing the apples with improved color was probably the result of the accidental propagation of a bud variation in the budwood used for the propagation of the Stayman Winesap apple block in the Moomaw orchard. The original entire-tree variation was purchased by a nurseryman in 1926 and has been commercially propagated and sold under the varietal name of Staymared. A somewhat similar solid red Stayman Winesap bud variation from the Wenatchee, Wash., district is shown in Figure 10, and a tree with a similar limb variation is also shown there.

Blaxtayman. Another variety originating as a bud variation in a Stayman Winesap orchard near Lake Chelan, Washington, has been given the name Blaxtayman and is being propagated and grown commercially in the Pacific Northwest. The trees of this variety resemble those of the parent variety, but the fruits develop a darker red color as they reach maturity.

Bud sport of Esopus. A striking limb variation in an Esopus Spitzenburg tree in an orchard belonging to W. H. Goodenough, Jr., near Hood River, Oregon, was studied by the writers in September, 1924, and September, 1930. This limb variation, shown in Figure 9 *E*, was discovered in 1922 by Mr. Goodenough, who had purchased the orchard the year before. It occurs on the north side of the tree and is one of the larger limbs starting from about two feet above the crotch of the parent tree. It bears apples that develop red color about two weeks earlier than the normal fruits on the same tree and when mature the apples have a very deep red color with much wider stripes than comparable normal Esopus Spitzenburg apples. The apples of this bud variation have the characteristic shape of those of the parent variety, but they do not seem to have quite so tart a flavor as the normal fruits. The foliage of the limb variation has a somewhat darker green color but is otherwise similar to that of the normal Esopus Spitzenburg limbs. Propagations of this striking limb variation have been made by Mr. Goodenough and the progeny trees have apparently identical characteristics to those of the parent limb.

Blackjon. One of the outstanding bud variations of another commercial apple variety that is now being propagated in the Wenatchee district of Washington has been named Blackjon. It was found as a limb sport, as shown in Figure 9*B*, in an otherwise normal Jonathan tree located in the J. N. Cox

orchard, now owned by T. R. Slack, near Wenatchee, Wash., in 1926. The deep, dark red color of the fruits borne by the parent limb, shown in Figure 10, as distinguished from the greener and reddish-striped apples produced by the other branches on the parent tree led to its discovery. Progeny tests of the limb variation proved that its characteristics were perpetuated through budding.

The fruits of the Blackjon bud variation are similar in shape and size to those of the Jonathan variety. They develop a deep and almost solid red color, while comparable Jonathan apples are still of a greenish color. Definite records of the relative productiveness of the Blackjon and comparable Jonathan trees are not yet available, but they appear to be similar in this respect.

The foliage characteristics of the Blackjon trees are apparently similar to those of comparable Jonathan trees. The Blackjon is being planted in certain apple districts such as Wenatchee and Yakima in Washington and particularly as pollinators in orchards of the red strains of the Delicious variety. The Blackjon strain of the Jonathan variety, as is the case with the others described in the foregoing paragraphs, is another illustration of an apparently important apple strain that originated as a bud variation during recent years.

Uses of Apple Tree-Performance Records

The term "apple tree-performance records" is here used to mean the records of the quantity of fruit borne by individual trees over a period of years together with descriptive notes on any outstanding or abnormal characteristics of the fruits and the foliage. The performance records that are now being kept in commercial apple orchards of the Pacific Northwest are being obtained by giving each tree a number and tying a strong paper tag about 3 by 6 inches in size at the same relative position on each tree on which the individual tree number, dates of picking, and the quantity of fruit of each pick can be recorded. If any abnormal or particularly interesting characteristic of the fruits or foliage of a particular tree are observed they are noted on the tags which are collected as soon as the apple harvest has been finished. The notes on the tags are copied onto performance-record blank forms where the data can be brought together and the results of each crop and those for a period of years for each tree can be analyzed and studied in detail by the growers.

There are three principal uses for apple-tree performance records: (1) comparing the results of orchard experimental tests, (2) the selection of undesirable trees for top-working or replanting, and (3) the selection of good type trees or limb sports for propagation. No attempt will be made in this article to discuss these subjects but attention is called to their increasing importance in the business of apple growing in order to obtain the maximum of efficiency in the orchards for the production of more uniformly good crops. The correspondence and orchard contacts of the writers indicate that there is an increase in the use of apple tree records in the orchards of the Pacific Northwest and that their use is being studied by growers in other apple growing districts.

Collecting Information As to Bud Variations

In order systematically to search for striking bud variations in apple trees, the plan for making such observations should be carefully considered. Early coloring variations in fruits, as illustrated in Figure 10, are most easily distinguished by looking over the trees in the orchard two or more weeks before the normal apples begin to color.

Late coloring variations, or those with green fruits as illustrated in Figure 9*F*, can be observed best after the normal apples have become fully colored. Limbs bearing abnormally large apples,

MUTANT LIMBS IN APPLE TREES

Figure 9

A—Stayman Winesap tree showing (center) a small limb variation bearing deep red fruits. J. H. Dickey, Wenatchee, Wash., Sept. 24, 1930. *B*—Jonathan tree showing a large limb variation (upper left) which bears deep red fruits from which the Blackjon variety has been developed by bud propagation. Orchard of T. R. Slack, Wentachee, Wash., Sept. 22, 1930. *C*—Winesap tree which produces very large flattened fruits on one large limb. In orchard of A. L. Tertsagian, Cashmere, Wash., Sept. 24, 1930. *D*—An old Porter apple tree in which one limb (lower left) is a sport bearing only seedless fruits. Orchard of Julian Dorrance, Scotland, Conn., Sept., 1917. *E*—Esopus Spitzenburg tree with limb variation (right) which produces very red fruits. Orchard of W. H. Goodenough, Jr., Hood River, Ore., Sept. 22, 1930. *F*—Winesap tree with limb variation (left center) bearing green fruits. The mutant limb is marked with a black cross. Orchard of J. H. Dickey, Wenatchee, Wash., Sept. 24, 1930.

as illustrated in Figure 9*C*, or those having different shapes from the normal, can be observed just before or at the time of picking the crop.

It is advisable to examine the seed content, particularly of fruit showing unusual shape, season of maturity, or other similar characteristics. A limb variation bearing seedless apples is shown in Figure 9*D*.

Some of the most important bud variations found thus far in deciduous fruit trees have been discovered by the growers or orchard workers incidental to cultural work and as a result of their ability to distinguish the abnormal from the normal fruit and foliage characteristics.

After limb or entire-tree variations have been found a record should be

made of their location so that they may be easily found for future observations. The tree number and a note as to the outstanding characteristics of the variation is usually sufficient. It is often desirable to tie a piece of rope or tag loosely to the limb or to the entire-tree variations to help identify them during subsequent observations.

Progeny tests of striking limb or entire-tree variations will determine whether or not their characteristics are transmitted through bud propagation. There are two methods of making such tests, (1) top-working an older tree with buds obtained from the variation, or (2) by budding a few nursery seedlings with the selected buds.

The top-working method will ordinarily give an earlier progeny performance reading than the nursery method, but the nursery-tree propagation test is generally considered the most satisfactory. Commercial nurserymen are usually glad to cooperate with the growers in such tests through supplying the seedlings and carrying out the budding.

Significance of Apple Bud Variations

The phenomenon of bud variation in apples has both scientific and commercial significance. From the scientific standpoint the study of the characteristics of apple bud variations, the causes of their origin, the frequency of their occurrence, the relation of bud variations to the development of off-type strains in the commercial varieties, and the use of desirable variations, in the improvement of varieties are of particular interest. Commercially, apple bud variations may be of significance from the standpoint of the isolation of better strains of the existing varieties through the selection and propagation of the valuable ones, the conservation of the established varieties through the use of buds for propagation from inherently stable and good-type parent trees and the elimination of inferior strain trees through top-working or by replanting.

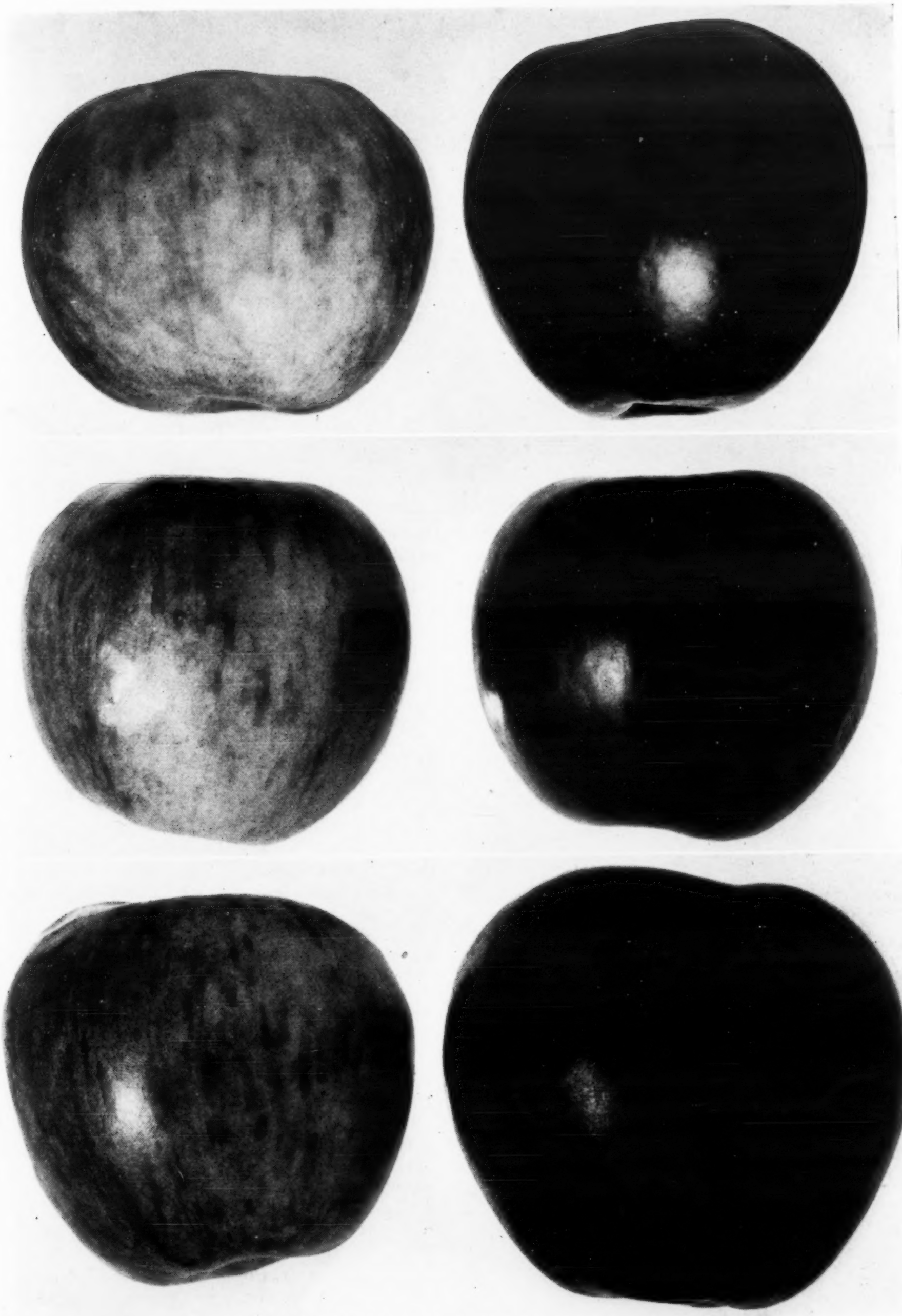
The scientific investigation of bud variation in apples is a recent development and work along this line has just been started. The commercial utilization of some of the strains originating from bud variations and their increasing importance in apple growing in certain districts will inevitably lead to an appreciation of the need for the scientific study of this phenomenon.

While the success of some of the red fruit strains of several commercial apple varieties indicates that they have financial value, it seems likely that bud variations in characters other than color will also become of importance through the development of strains that produce apples having better characteristic shape, size, texture, or flavor, or more regular bearing, as compared with those characters of the parent varieties. Color variations or those correlated with color changes are most easily found because they strike the eye of the observer most forcibly. Variations in other characteristics are less apparent and require closer observation in order to find them than do those that are distinguished by reason of marked color differences. However, it has been found that experience in searching for color variations is a helpful training in the systematic study of trees for the purpose of finding variations of characteristics other than color.

Summary

The increasing commercial use of strains of apples originating as bud variations in some of the apple growing districts has stimulated an interest in the study of the phenomenon of bud variation and the practice of bud selection from both the scientific and the commercial points of view.

The possibility of improving the commercial quality of some apple varieties has been demonstrated through the isolation and propagation of strains that produce fruits having superior commercial value in one or more characteristics as compared with those of the parent varieties.



COLOR VARIATIONS IN APPLES

Figure 10

Solid red fruits from limbs of otherwise normal trees of Stayman Winesap (top), Jonathan (center) and Winesap (bottom). Normal apples from the same trees are shown at the left in each instance. Two of these trees are at Wenatchee, Washington, and one at Monitor, Washington (bottom). The Jonathan variation has been propagated and is being rather extensively grown as the Blackjon variety. Photographed December, 1930.

The scientific study of apple bud variations includes the systematic gathering of information concerning their characteristics, the frequency of their occurrence, their perpetuation through bud propagation, and comparative studies of their commercial quality and quantity of production with the yields of comparable trees of the parent varieties.

Apple bud variations are of significance to the growers from the standpoint of the development of valuable strains from desirable variations, the elimination of undesirable strains in commercial nursery practice through avoiding the propagation of the inferior ones.

At the present time 173 bud variations are known, some of which are almost surely destined to become of commercial value to the apple industry of the United States; the remainder are of scientific interest from the standpoint of the study of bud variation in apples. With increasing interest in the commercial importance of this subject and a greater familiarity with the characteristic appearance of bud variations by growers, many additions to this list are almost certain to be made in the near future.

It is, as yet, too early in the study of this subject to evaluate fully its commercial importance or scientific significance, but it can be stated that it seems likely that the subjects of bud variation and bud selection in apples will become of much greater interest during the next few years than has been the case during the past.

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Eugenics and Democarcy—A Paradox

In the *Eugenics Review* for October, 1931, R. Austin Freeman offers a plan for the "Segregation of the Fit," a plea for positive eugenics:

Probably few of us have any doubts that if these principles of eugenic reform [reversing the differential birth-rate] could be put into practice, a steady, if slow, improvement of our population would result. But it is just at this point that a most formidable difficulty arises. Measures of eugenic reform applicable to the whole population could be enacted only by the State. Legislation would be necessary; and that legislation would have to be of a kind that would encourage the multiplication of the definitely superior classes while discouraging or restraining that of the definitely inferior. But is any such State action imaginable in the prevailing political conditions or in any political conditions that may prevail in the calculable future? The answer is given in Mr. Bertrand Russell's curt dismissal of eugenics as a practicable policy: "Democracy stands in the way."

The obstacle seems to be insuperable. Democracy—or, at least, our present democracy—is based on the assumption that all men are born equal. Eugenics is based on the observed fact that men are born very unequal. Eugenics seeks to perpetuate the superior stocks and to eliminate the inferior. Democracy denies the existence of either and seeks, through environmental agencies, to give effect to a postulated inborn equality. The two principles are at opposite poles, and the respective schemes of social policy which logicaly issue from them are mutually irreconcilable.

Nor is it a mere question of opposition in theory. The principles of democracy are being put very energetically into practice; and since those principles are the opposite to eugenic principles, so the practice is the opposite to eugenic practice; that is to say, it is dysgenic. In its enthusiasm for equality, democracy even tends to fly past its theoretical objective and create a privileged class; which class includes the very group that eugenic reform would seek to eliminate. The dysgenic tendency is thus inherent in the present political system; for, whereas the multiplication of the less capable—and even the definitely unfit—is encouraged by subsidies, the more capable minority are hindered from rearing even moderate families by the drastic taxation which is necessary to provide those subsidies.

Moreover, this is no passing phase. Universal suffrage combined with immense pecuniary gifts to a large part of the electorate create a situation from which retreat is almost impossible. We must assume that the present political system, with its subsidies to the inferior at the expense of the superior, will continue until its economic and biological unsoundness manifests itself in some national catastrophe. Meanwhile, eugenics, as defined above, must apparently remain a more or less academic study of a social policy whose application appertains to some remote and unvisualized future. * * *

Of this deterioration there are two complementary factors, which may be considered separately; the increase of the inferior stocks and the decrease of the superior. These factors are of very unequal importance. For, whereas the relative increase of the least intelligent part

of the population is a grave evil, tending to produce impossible social and political conditions, it does not of necessity involve the utter destruction of the present civilization; the disappearance of the superior types would bring civilization definitely to an end. A population composed mainly of persons of the unskilled labourer type would be utterly unable to maintain anything resembling national life. * * *

The political and economic confusion of the modern world, the financial distress combined with wild extravagance, the general march towards insolvency, the combination of paid unemployment with scarcity of labour, and the spectacle of nations but half recovered from one great war, busily preparing for another; are surely the indices of declining intelligence. The political phrase, "world conditions" is scientifically meaningless. There are no cosmic or other conditions beyond human control that are responsible for this muddle. The social environment of today is undeniably the product of human conduct. Whatever the difficulties of modern man may be they are of his own creating. The recurring "crises" and the endless conferences associated with them seem to suggest that modern man is less capable of reasonably managing his affairs than were his recent ancestors; which yields the further suggestion that his general capacity—his intelligence and character—has already appreciably declined.

—Segregation of the Fit. *Eugenics Review* (London) October, 1931. Pp. 207-213.

Mr. Freeman feels that the only alternative to this situation is the formation of communities limited to individuals of superial endowment and superior stock. He realizes that the difficulties in the way of such an organization are formidable; he believes however that the success of M. Alfred Dachert in founding Les Jardins Ungemach near Strasbourg, in Alsace, Lorraine, offers a ray of hope:

To this question M. Dachert's experiment seems to have given an answer as surprising as it is encouraging. In his eugenic settlement, Les Jardins Ungemach, the birth rate has been more than double that of the adjacent city of Strasbourg, while the excess of births over deaths has varied from about six times to thirteen times that of Strasbourg. It is true, as M. Dachert points out, the figures are not strictly comparable. But they are highly significant, and, as he says, "all the more striking since our citizens belong to just that class which is deemed the most infertile, the small clerk and small official class." This rather unexpected result does, in fact, encourage us to believe that in a eugenic community the conscious attention to the inborn qualities of the children would result in a greater willingness to rear families of a size at least sufficient to maintain the population by natural increase. (*Ibid*, P. 210)

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